National Livestock Resources Research Institute (NaLIRRI

Addressing Animal Nutritional Constraints in Uganda: The Contribution of the Livestock Nutrition Research Programme



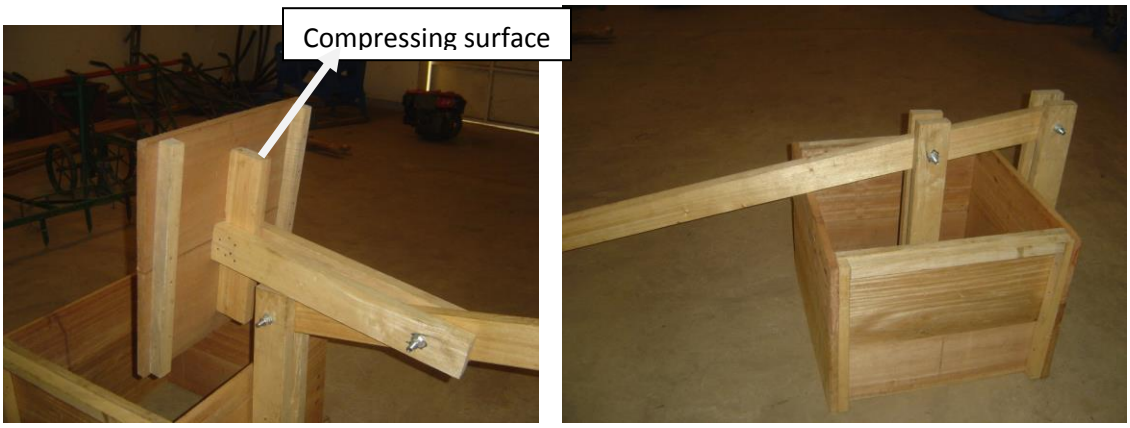
INTRODUCTION

The Livestock Nutrition Research Programme is one of the four programmes that constitute the Livestock Resources Research Institute (NaLIRRI) located in Eastern region (Tororo District) of the country. The programme seeks to contribute to improved food and nutritional security, household incomes and stability of the bio-physical and socio-economic components of the production environment in a participatory and client-oriented approach. Specifically, the programme seeks to generate and disseminate technologies and information that directly addresses animal nutritional challenges in the country. During recent times, the programme has made considerable progress in the area of technology and information generation. In this brochure, we highlight key accomplishments of the programme in relation to technology and information generation.

(A) Technology generation

1. Prototypes developed

- ***Modified hay bailer prototype***: The Livestock Nutrition Research Programme in collaboration with the National Research Laboratories (NaRL) developed a wooden hay baler prototype with a compressing surface to reduce the time and drudgery spent in compressing hay while using the traditional hay bailers.



Hay bailing box prototype with a compacting surface

- ***Wooden forage chopper prototype***: Still in collaboration with the National Research Laboratories (NaRL), the programme developed a wooden forage chopper prototype that is less costly, less bulky, requires limited storage space and can easily be adjusted to be operated by people of different heights including children. The modified prototype was developed in response to challenges that farmers faced in utilization of the metallic forage chopper prototype previously used by farmers. The constraints included: (1) the prototype was entirely metallic making its purchase price high, (2) bulky to carry, (3) required big storage space and (4) too high for children & short users. The modified wooden chopper has a detachable wooden surface that can be fixed on wooden stands of heights appropriate to the user.


Metallic forage chopper Modified wooden forage chopper

- In an attempt to mitigate the devastating effects of Napier stunt disease (NSD) on the productivity of Napier grass, the program has evaluated and came up with three accessions that are tolerant to the disease. The accessions include Kakamega 1, accession 16702 and accession 112 and are recommended for farmer uptake especially in the Lake Victoria crescent zone where the incidence of the disease is very high.



Accession Kakamega 1



Accession 16702

2. Protocols generated

- ***Protocol for pasture restoration on degraded bare crusted soils***: The protocol involves relieving the degraded bare surfaces from animal activity by fencing off the area using locally available fencing materials. It is recommended that branches of highly colonizing woody species or any other invasive woody species be used to construct fences as this checks their colonization. Trenches are then dug around the enclosed area following the direction of flow of running water to reduce the speed of run-as well as preventing further soil erosion. The enclosed areas are then night kraaled with a herd of cattle during the dry season to ensure that at least a two inch layer of animal manure accumulates on the soil surface. When the rain season commences, remove the animals and broadcast the enclosed manured area with appropriate grass and legume seed species. Keep the area free from heavy grazing until when the established pasture produces and drops seed to restore the soil seed bank for sequent seeding. Light grazing using calves is recommended after 2 months of seedling emergency to enhance tiller development. The protocol improved pasture dry matter production from 0 on degraded bare surfaces to 4500 kg/ha^{-1}. The increment in dry matter production led to improvement of the area's carrying capacity from zero on bare surfaces to 1.6 livestock units (LU) per hectare. Also, the protocol was associated with improvement of soil properties from 3.4, 1.3 and 0.07 to 5.8, 3.1 and 0.2 for soil pH, organic matter and nitrogen. The protocol was developed in very close collaboration with Makerere University and the International Livestock Resources Research Institute.



Degraded bare surface in Nakasongola



Bare surface after manure deposition



Establishing pasture after removal of cattle herd



Full restored pasture vegetation

3. Management practices developed

- ***A cost effective phosphate fertilizer regime for Lablab seed production***

Upon evaluation of seven phosphate fertilizer regimes (0, 15, 30, 40, 60, 80 and 100kg of P_2O_5) for lablab seed production and economic benefits, the results were suggestive that application of Phosphate fertilizers at 30 kg of P_2O_5 ha^{-1} is most profitable and hence recommended application rate for lablab seed production. Lablab seed yields from plots subjected to 0, 15, 30, 40, 60, 80 and 100kg of P_2O_5 were 1253, 1560, 1753, 1380, 1560, 1680 and 1540kg/ha whereas the net benefits (gross field benefits-total costs that vary) associated with the same treatments were US$ 1542, 1856, 2030, 1529, 1666, 1729 and 153 respectively. The results are applicable to soils with high concentration of Phosphorus fixing ions (particularly Mn^{2+} ions) where application of high levels of Phosphorus is rendered uneconomical as the phosphate ions are rendered unavailable for plant up take due to fixation processes.

- ***Integration of forage legumes into cereal cropping systems***

In a study to evaluate the effect of intercropping maize with lablab, fodder dry matter yield, grain yields, and cob size were increased by 26, 7 and 6%, respectively when maize was intercropped with lablab compared to maize pure stand fields (4,373 kg/ha/year; 2,912 kg/ha/yr; 134 g respectively). The mean crude protein content of residues from maize-lablab intercrop (8.4%) was 1.9 times higher than the stover obtained from maize pure stands. The results are suggestive that integration of forage legumes in cereal cropping systems enhances the quality and quantity of fodder to fill the feed gap during the dry season while improving maize grain yield from the same piece of land. Improving forage yields and/or forage quality without adversely affecting grain yield is an attractive option to intensive smallholder farmers who constantly seek for technologies to improve productivity per unit of available land.



An intercrop of maize and lablab for improved grain and fodder production

- **A cost effective poultry manure application rate for cabbage production in smallholder crop-livestock production systems**

Upon evaluation of five poultry manure applications rates (0, 1, 2, 3 and 4 t/ha^{-1}) for cabbage production in smallholder crop-livestock production systems, the results were suggestive that application of poultry manure at 4 kgha^{-1} is the most profitable and hence recommended application rate for cabbage production in smallholder crop-livestock farming systems. Cabbage yields from plots subjected to 0, 1, 2, 3 and 4kgha^{-1} were 35328, 26257, 35993, 42500 and 46331 kg/ha whereas the net benefits (gross field benefits-total costs that vary) associated with the same treatments were US$ 2936, 2114, 2782, 3310 and 3564. The results were indicative that applications rates of 1 and 2 are totally uneconomical as the associated net benefits are below that obtained at 0 kgha^{-1} application rate. The results are applicable to smallholder crop-livestock production systems where application of high quantities of animal manure is limited by the inadequate availability of manure.

- **Napier stunt disease management package**: Napier grass (*Pennisetum purpureum*) fodder productivity is threatened by Napier stunt disease (NSD) which causes a reduction in Napier grass fodder yield of up to 60%. As such, a disease management package was developed. The package consists of the follows guidelines:

a) Use of Napier stunt tolerant accessions: On farm evaluation of 22 Napier accessions obtained from the Regional Dairy Centre of Excellence, Kenya Agricultural Research Institute was suggestive that Kakamega 1, clone 16702 and clone 112 –are considerably tolerant to the disease and are recommended for farmer uptake especially in the Lake Victoria crescent zone where the incidence of the disease is very high.



Multiplication of tolerant Napier grass clones


Sampling for herbage biomass

b) Plant disease free cutting materials: Although some accessions are tolerant to the disease, they are not completely resistant and efforts need to be taken to plant disease free planting materials by observing for disease symptoms on the parent materials.
c) Apply organic manure preferably cattle manure: Amendment of Napier fields with organic manures enhance soil properties which in turn improves the plant growth vigor and eventually renders the plant less vulnerable to biotic and abiotic stress.
d) Uproot and burn affected plants: Once the plant succumbs to the disease, uproot and burn affected plants to prevent further spread of the disease to health plants
e) Use appropriate cutting frequencies: frequent cuttings exposes the plant to disease vectors (leaf hoppers) that spread the disease causing organisms (*Candidatus Phytoplasama oryzae*;16SrXI). Cutting of the grass triggers development of succulent tillers which eventually attract leafhoppers in search for cell sap. So the more times the grass is cut, the more it's exposed to disease vectors. The appropriate cutting interval is 2 months.

4. Feed formulations developed

- ***Homemade dairy meal ration***

A homemade dairy concentrate comprising:

Ingredient	**Percentage (%)**
Maize bran	75
Cotton seed cake	15
Calliandra	9
Mineral powder	1

Supplementing a basal diet of Napier grass fodder with 3 kg DM/cow/day of Lablab hay and 2 kg/cow/day of a homemade concentrate increased milk yield by about 25% compared to unsupplemented cows. A simple cost-benefit analysis showed an increase of 5% in gross margin when cows were fed on supplemented ration.

- ***Maize stover- bentonite feed block ration***:

A maize stover-bentonite feed block comprising of maize stover (50%), maize bran (11%), calliandra (25%), cotton seed cake (8%), and calcium betonite (6%) was formulated and evaluated. Supplementation of lactating cows with the ration resulted in doubling of milk production as compared to blocks lacking calcium bentonite. The increment was attributed to provision of minerals for animal physiological processes and sequestration of aflatoxins in dairy feeds.

- ***Sorghum stover-tithonia feed ration***

In order harness the massive quantities of locally available sorghum stover and *Tithonia diversifolia*, supplementary feed rations for lactating cows based on sorghum stover and Tithonia as energy and protein sources were formulated and evaluated. The results were suggestive the rations comprising of Maize bran (11.9%), Tithonia leaf hay (31.1%), Molasses (47.9), Sorghum Stover (9.1%) was identified as the best ration and led to a 16% increase in milk yield. This highlights the potential of sorghum stover and *Tithonia* as alternative feed resources for lactating animals.

- ***Multi-nutrient feed blocks ration*:**

Homemade multi-nutrient feed block technology was introduced on-farm to provide dairy cattle with a cheap source of protein, energy and minerals. The blocks are made using locally available materials such as farm waste (feed refusals) and agro-industrial by-products.



Homemade Nutrient feed blocks


Cow licking a nutrient mineral block

An example of a homemade multi-nutrient block ration comprising of 13% crude protein would include 35 kg of Chopped maize stover or dry grass, 11 kg of Maize bran, 10 kg of Calliandra/Gliricidia leaf hay, 30 kg of molasses, 10 kg of cotton Seed cake and 4 kg of cassava flour (binder). Upon supplementing dairy cows fed fed low quality feeds, the multi-nutrient block ration improved milk yield by 20%. Supplementation of dairy cattle with multi-nutrient feed blocks provides nutrients (protein, energy and minerals) required by both the rumen microbes and the animal and improved milk yield. Supplementing multi-nutrient feed blocks to

dairy cows also reduces emissions of methane gas and hence contributing to reduced global warming. Also, sale of nutrient feed blocks by farmers increased household income.

5. **Software developed**

- ***The dairy feed resources utilization decision support tool (Endiisa tool)*:** The endiisa tool is a computer based decision support tool designed to help dairy farmers develop least cost feed combinations to meet the nutritional requirements of dairy cattle. The tool thus assists users to make decisions on feed combinations that cost-effectively meet the nutritional requirements of lactating animals. Using the tool involves selecting the feeds at the farmer's disposal, describing the animal for which the feed combination is being developed and costing the feed stuffs. The tool may accessed on the NARO-website: (**http://www.naro.go.ug/endiisa/tool.html).**

- ***NUTBAL model (Nutritional Balance Analyser)***

The Livestock Nutrition Programme participated in the development of equations currently used in NIRS through calibration with fecal samples from the grazing animals collected at various sites in the country. Ultimately this contributed to the development of the global equation used at Texas A&M University, the institution behind the development of NIRS / NUTBAL Nutritional Management system. Fecal sample scan with NIRS provides an estimate of percent CP and DOM of the diet of the animal. The CP and DOM values are then input in NUTBAL, a nutritional management model. NUTBAL is a decision support system which models crude protein and net energy status of cattle, sheep and goats. NUTBAL monitors the nutrient concentration in the animal's diet and allows estimation of animal performance whose outputs include nutrient balance, weight gain / loss, expected and actual milk yield, nutrient requirements, fecal outputs in addition to mediation strategies to improve the economic status of the enterprise. The system has been used to estimate livestock performance in livestock systems in S.W. Uganda. The NIRS machine is available at Namulonge and the NUTBAL PRO software is also available.

Contribution to technology dissemination

- ***Multiplication and distribution of forage seed***

In an attempt to address forage seed scarcity in the country, seed for various forage species including Napier grass clones tolerant to Napier stunt disease, lablab, Rhodes grass, Brachiria grass, Centro, Desmodium, and *Clitoria ternatea* among others, have been bulked and distributed to stakeholders in the various districts in Uganda. A map showing the districts where the seed was distributed is provided (Figure 1). The program continues to multiply seed of various forage and the seed can be accessed from the Dairy Business Incubation Center at Nakyesasa.



Brachiaria Hybrid cv Mulato seedlings multiplied at NaLIRRI



Packaged Lablab seed supplied to farmers by NaLIRRI



Chloris gayana multiplication field at NaLIRRI



Brachiaria brizantha multiplication field at NaLIRRI

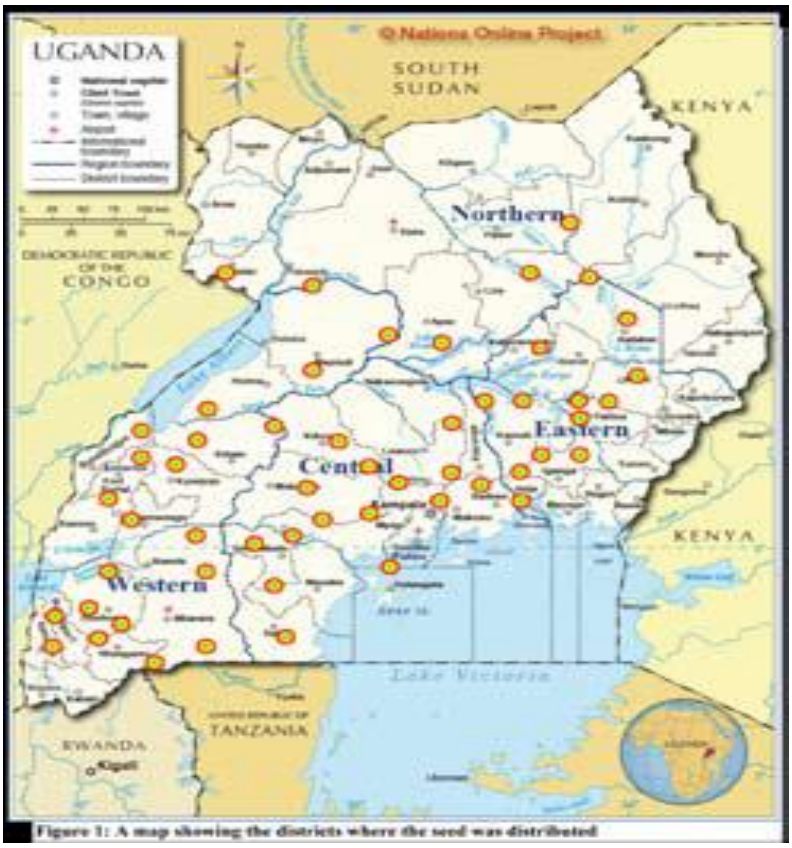


Figure 1: A map showing the districts where the seed was distributed

- **Dissemination of climate smart agriculture technologies and innovations**

The productivity of smallholder crop-livestock production systems in Eastern and Central Africa is threatened by adverse effects of climate change; with severe consequences on livestock feeds, water and household livelihoods. A project was implemented in Uganda, Kenya, Tanzania and Burundi during 2009-2011, to promote utilization of drought tolerant forages, rain water harvesting, and use of soil fertility enhancements as coping mechanisms against climate change shocks, especially in the dairy-vegetable production systems. Drought tolerant forages that were evaluated and promoted included *Brachiaria* hybrid cv. Mulato (Brachiaria) and *Pennisetum purpureum* intercropped with forage legumes. Livestock manures from the farms were utilised to replenish soil fertility for vegetable production. Rain water was harvested for domestic and livestock uses and to drip irrigate vegetable (cabbage) grown on plots amended with either goat, cattle or poultry manure.



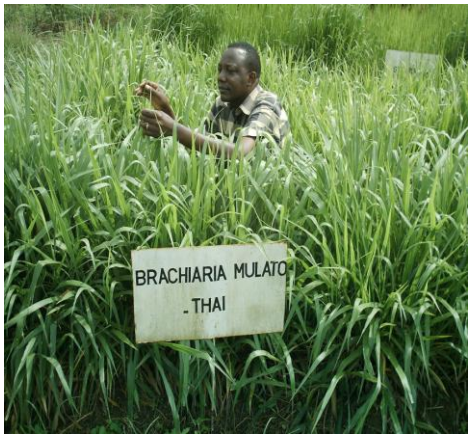
Water harvesting from the roof



Harvesting water from surface run-off



Simple irrigation for year-round vegetable production



Drought tolerant Brachiaria spp.

The project involved 280 smallholder dairy-vegetable production system farms, most of which had women as key players. From the study, introducing 0.5 ha of a mixture of Brachiaria and *Clitoria ternatea* on farms previously dependent on 0.5 ha of *P. purpureum* and *Centrosema pubecens* mixture, provided year round feed supply to dairy cattle. Drought tolerant forages and water harvesting technologies increased fodder availability (76%), water offered to animals (46.3%), milk yield (78.7%) and cash incomes (52.4%). Application of goat, cattle and poultry manure with drip irrigation significantly ($P<0.05$) increased cabbage yield by 9%, 49% and 95%, respectively. In conclusion, integrated management of climate change adaptation technologies in dairy-vegetable production systems improved food security and income. Relevant policies should be bolstered to enhance adoption of climate change coping technologies, as a strategy for improving livelihoods.

B) Information generated

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List of technical manuals/ Newsletters/ newspaper articles/Brochures/ Factsheets/Leaflets

1. Small-scale forage seed production
2. Silage making for smallholder dairy farmers
3. Climate smart agriculture technologies and innovations for rural poor farmers
4. *Lablab purpureus* cv. Rongai establishment and management
5. *Caliandra calothyrsus* establishment and management
6. Establishment, management and utilization *Gliricidia sepium* (Glicidia)
7. Cereal crop-forage legume intercropping for food and fodder production
8. *Brachiaria mulato* as an alternative forage in smallholder dairy systems
9. Napier grass establishment and management for small-scale dairy farmers
10. Napier Stunt Disease Management Strategies for Increased Feed Availability in Smallholder Farming Systems in East and Central Africa
11. Enhancing Adoption of Napier Grass Varieties Tolerant to Stunt Disease for IncreasedFeed Availability in Smallholder Dairy Systems in East and Central Africa: Achievements (September 2011- February 2013) and Planned activities (2013-2014)
12. Nutrient feed block supplement for goats and cattle

13. Fodder conservation in smallholder crop-livestock systems in Eastern and Central Africa region
14. *Brachiaria*hybrid cv. Mulato 1, a promising forage for smallholder dairy farmers in Eastern and Central Africa region
15. Utilization of Calicium bentonite to detoxify aflatoxins in animal feeds and as a mineral supplement in lactating animals
16. Water harvesting and management for livestock and crops
17. Harnessing crop-livestock integration to enhance food security and livelihoods resilience to effects of climate variability in Eastern and Central Africa (LFP PRJ 12): Key outputs and impacts
18. Climate smart agricultural technologies and Innovations for improved livelihoods of smallholder dairy and livestock farmers in Eastern and Central Africa region
19. Role of fodder trees in crop-livestock farming systems in Eastern and Central Africa region
20. Ustawishaji, *Utunzaji* na Utumiaji wa Gliricidia (*Gliricidia sepium*)
21. Ustawishaji na Utunzaji wa Mti-malisho aina ya Kalliandra (*Calliandra calothyrusus)*
22. Ustawishaji, Utunzaji na Utumiaji wa Lablab (*Lablab purpureus*)
23. Mwongozo wa jinsi ya kutumia kwanja la kukatakatia malisho ya mifugo katika mazingira ya wafugaji wadogo wadogo wa ng'ombe wa maziwa
24. Mfumo wa Umwagiliaji maji kwa njia ya matone kwa wakulima wadogo (Smallholder Drip Irrigation Systems)
25. Ustawishaji, utunzaji na utumiaji wa malisho bora ya mifugo
26. Family Drip Irrigation System for Smallholder Farmers
27. Working with farmer groups
28. Gender-Targeted Forage chopper for smallholder dairy farmers
29. Role of vegetables in smallholder dairy farming systems
30. Harvesting and Processing Vegetables
31. Water harvesting and management for livestock and crops

Services offered by the program

1. Formulation of feed rations, feeding strategies
2. Consultancy in livestock nutrition principles, innovations and practices including execution of livestock nutrition surveys
3. Training stakeholders along the livestock nutrition value chain
4. Farm designs: silage silos, hay barns, zero-grazing units, e.t.c.
5. Laboratory analysis of feed samples
6. Production and supply of conserved feeds such as hay and silage
7. Production and supply of forage seed/planting materials
8. Supply of superior dairy heifers

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